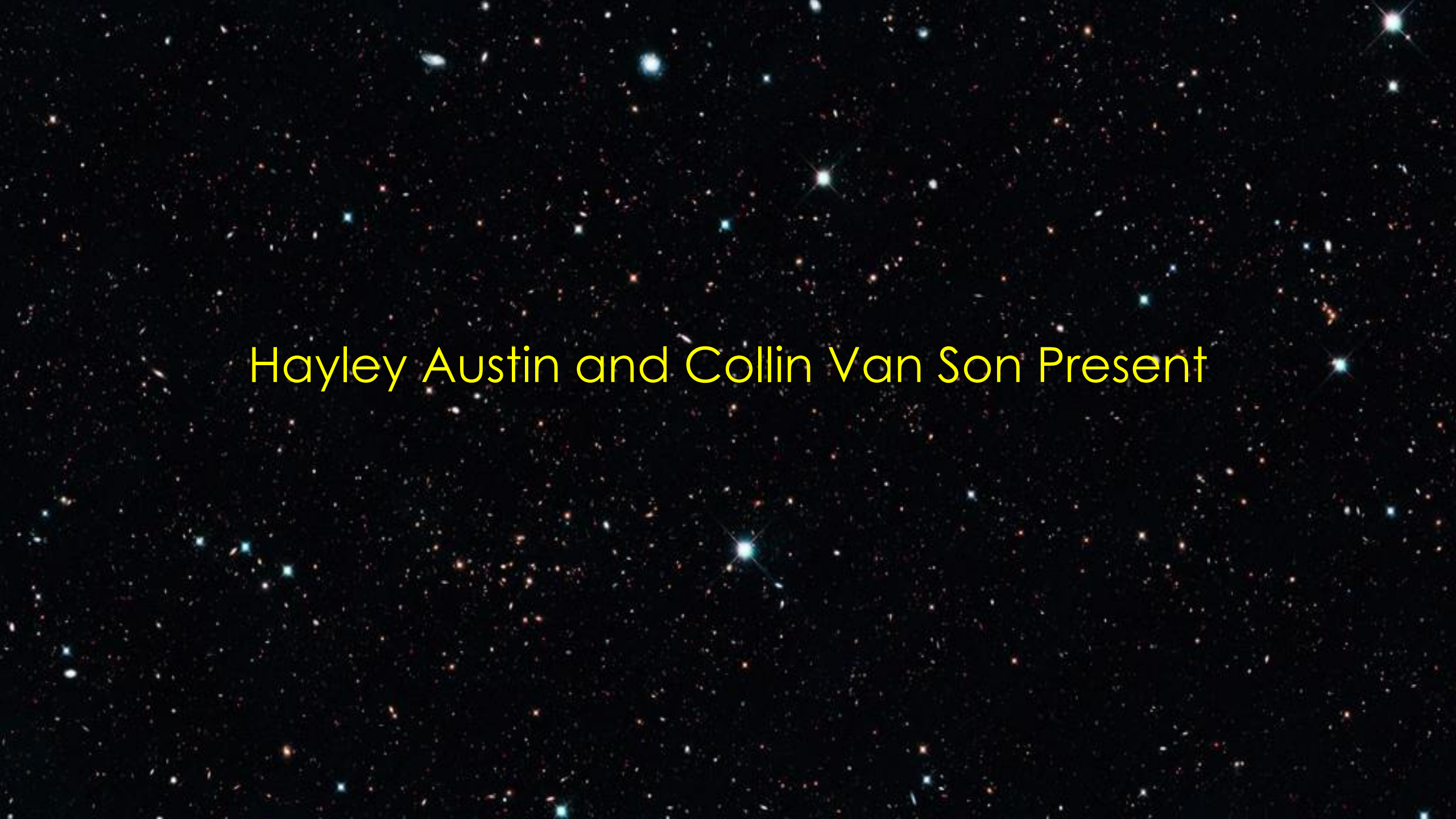

Hayley Austin and Collin Van Son Present

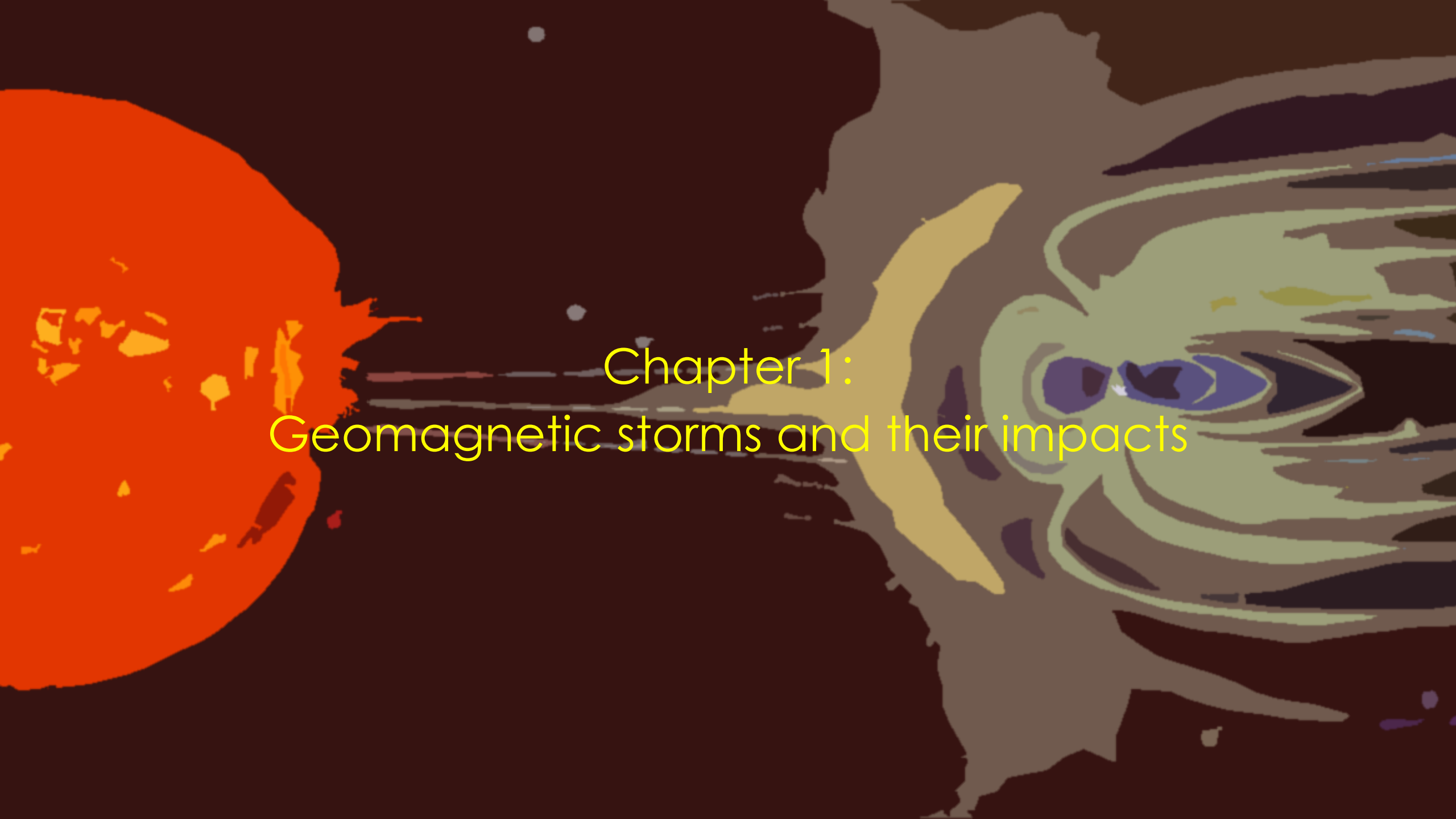

In association with Neel Savani

Exploring the Real-Time Value of the Bz4Cast Tool


Prologue:
Project Overview

Overview

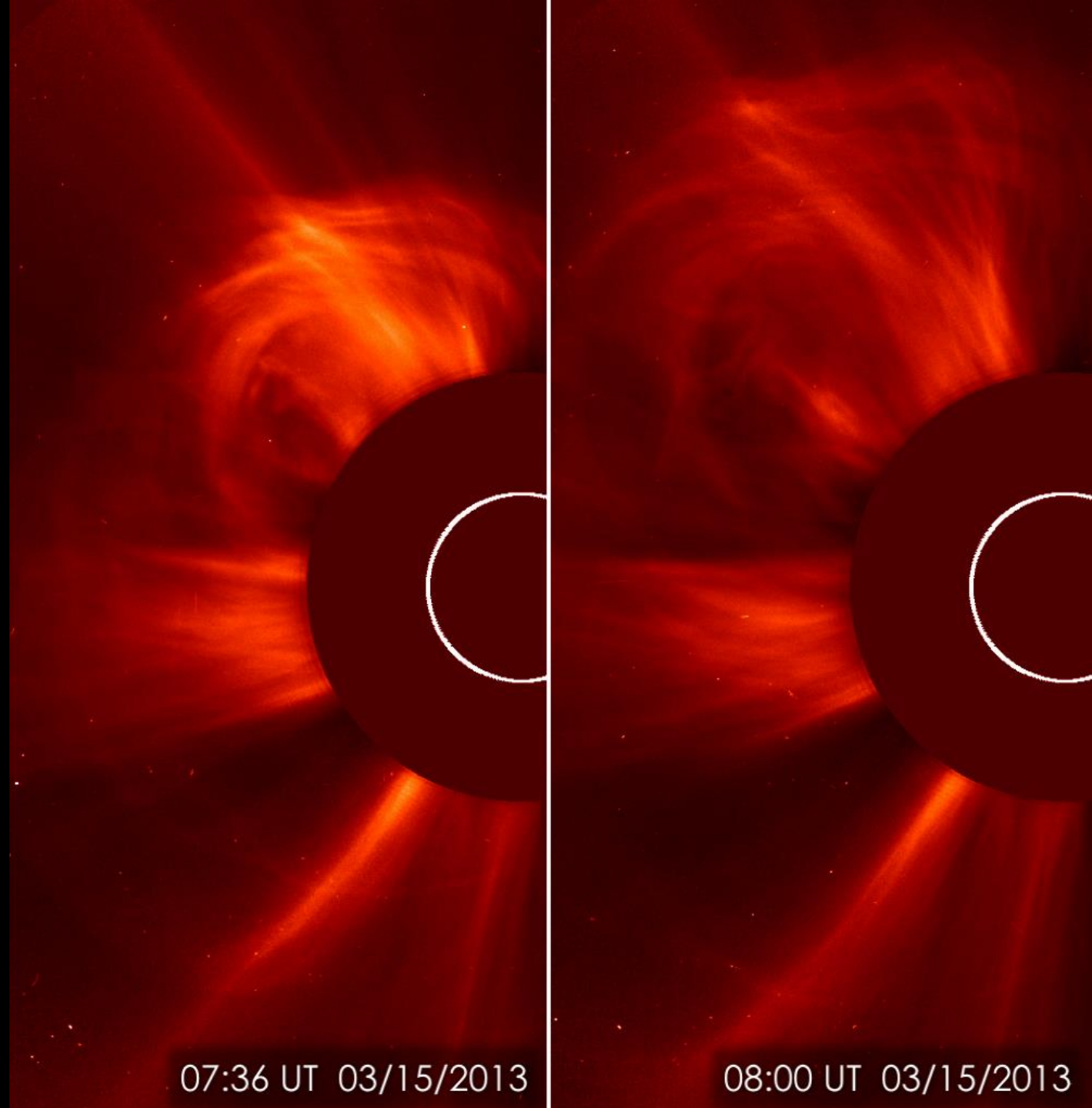
- The Bz4Cast Tool predicts the orientation of a CME's magnetic field
- To improve the quality of model inputs, the accuracy of ENLIL's magnetic field and solar wind speed predictions were measured using a sample of 53 CMEs
- "Rules of thumb" were developed to modify ENLIL predictions into more valuable inputs
- Evaluated using an array of skill scores



Chapter 1:
Geomagnetic storms and their impacts

Geomagnetic Storms

- Caused by Coronal Mass Ejections (CMEs) that carry intense magnetic fields
- Depending on field orientation, can cause severe disruption of Earth's magnetic field



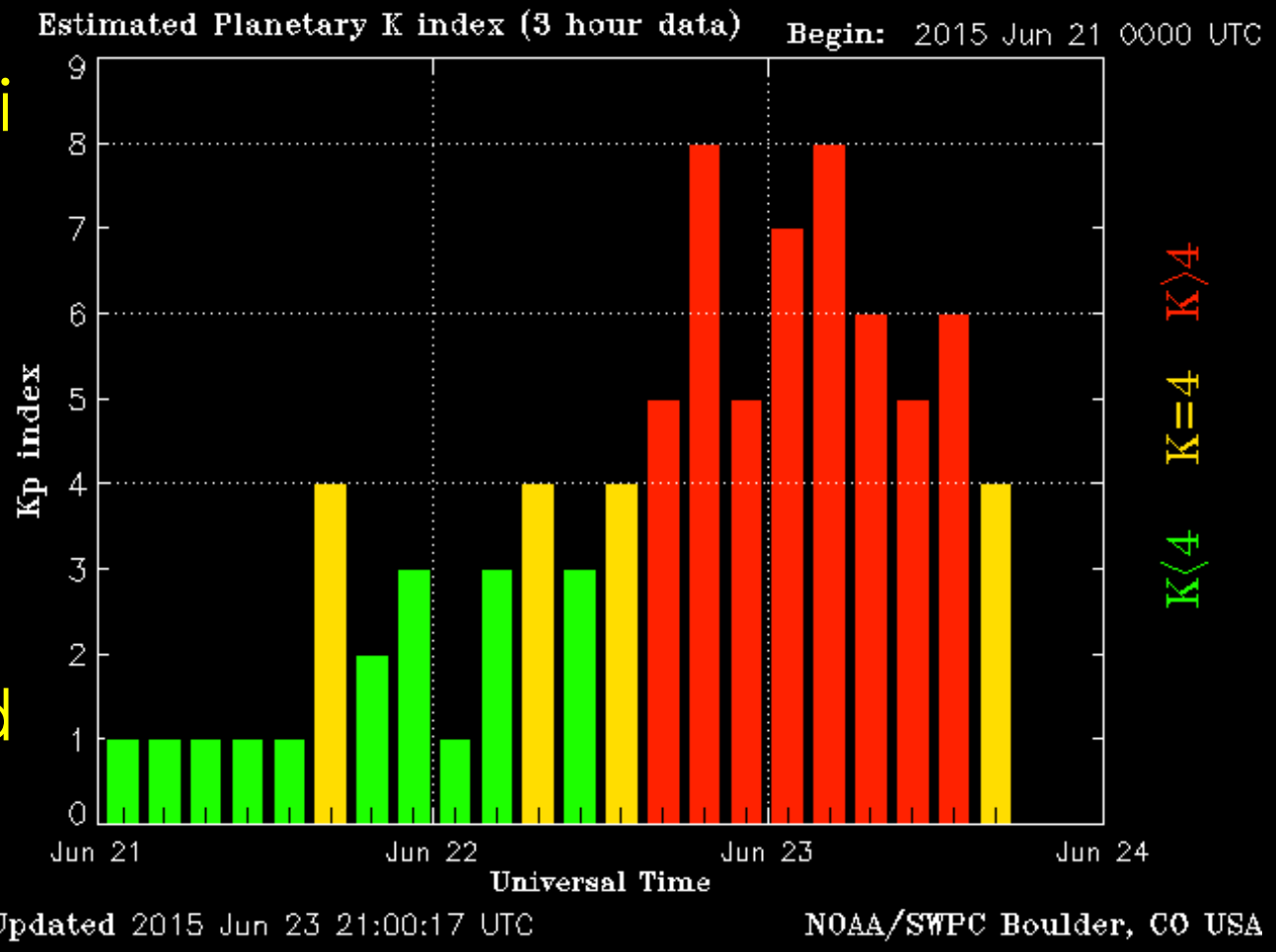
Impacts

- Interfere with satellite operations
  - Surface charging
  - Single event upsets
- Interrupt power grid operations
  - Ground induced currents
- Disrupt GPS signals and communications
- Enhanced auroras

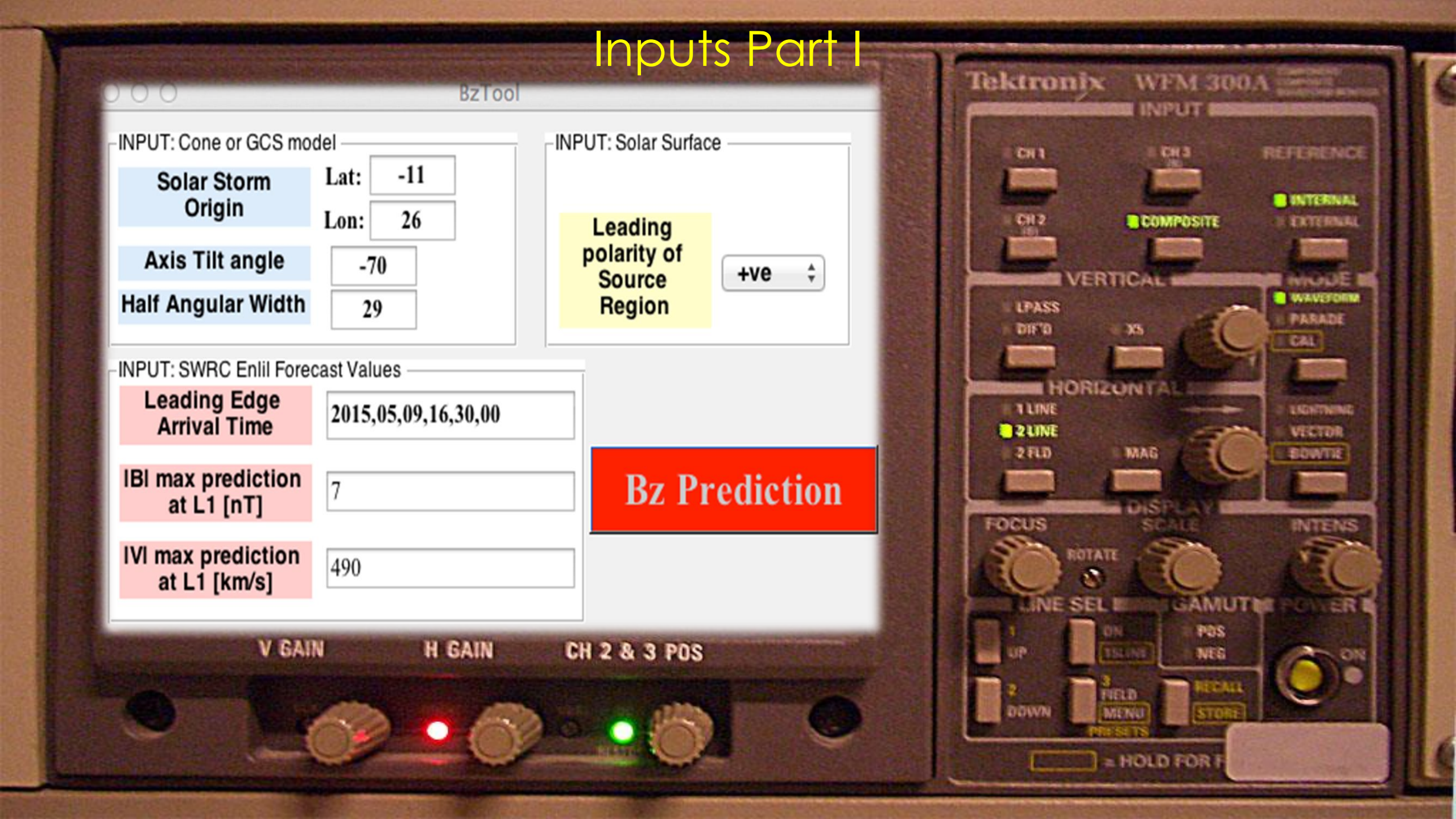

Chapter 2:
The Bz4Cast Tool: Advantages and Limitations

The Bz4Cast Tool

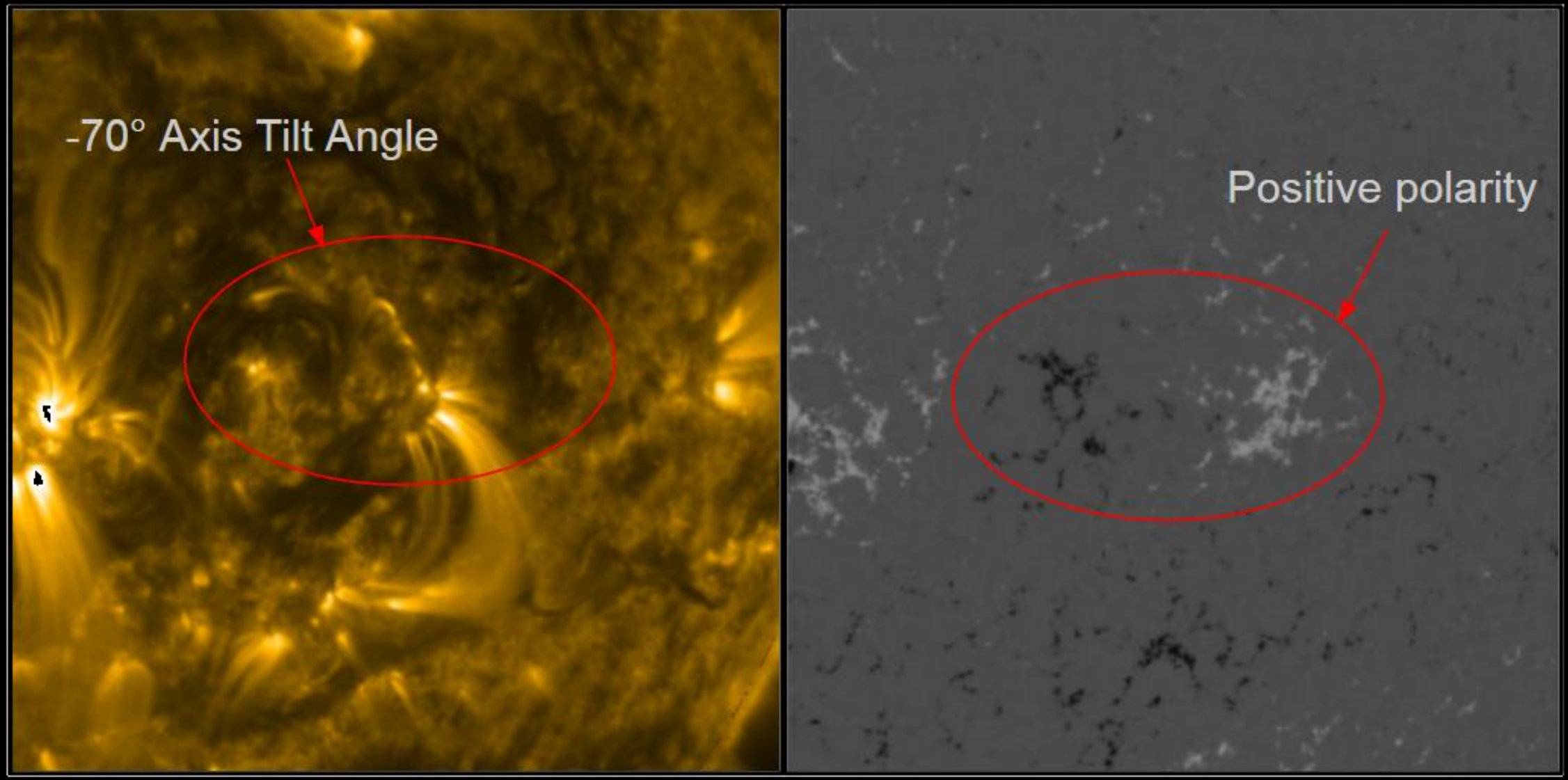
- Developed by Dr. Neel P. Savani
- A statistical and topological model that predicts geomagnetic storm intensity
- Current Kp predictions are based off observations at L1, leaving less than an hour of lead time
- Bz4Cast allows Kp predictions to be made days in advance



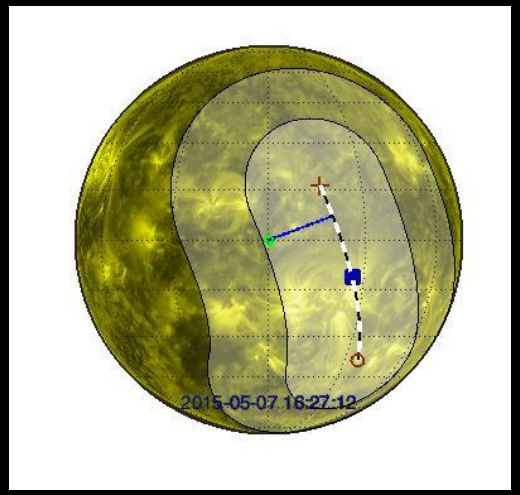
Inputs Part I



Inputs Part II



Outputs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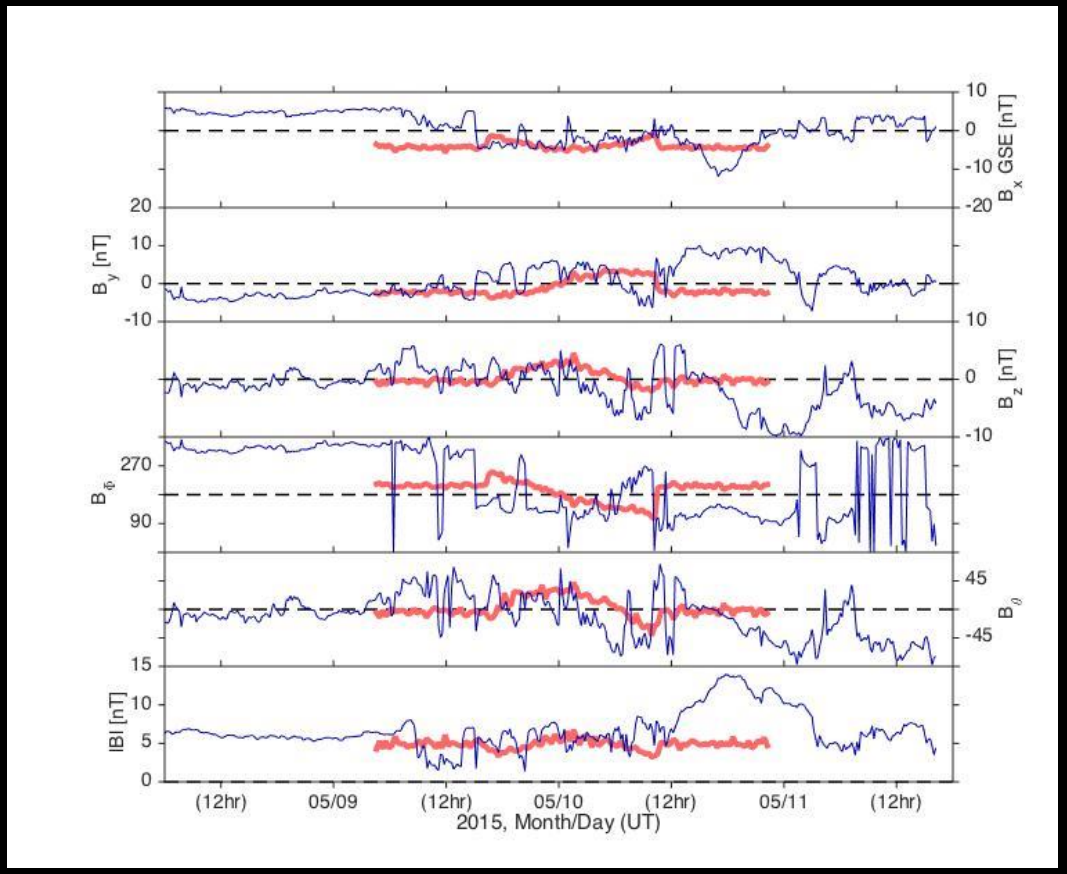
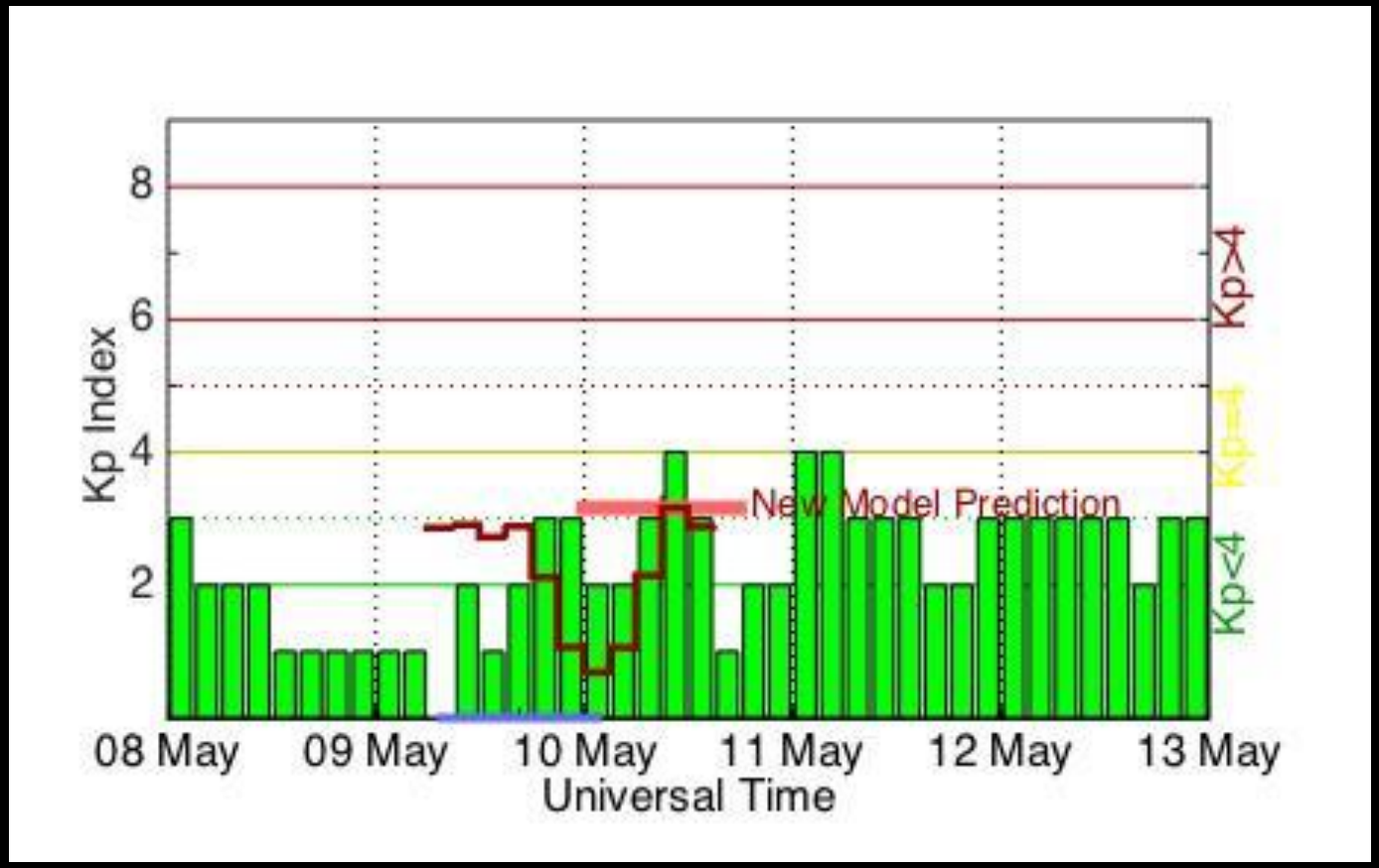
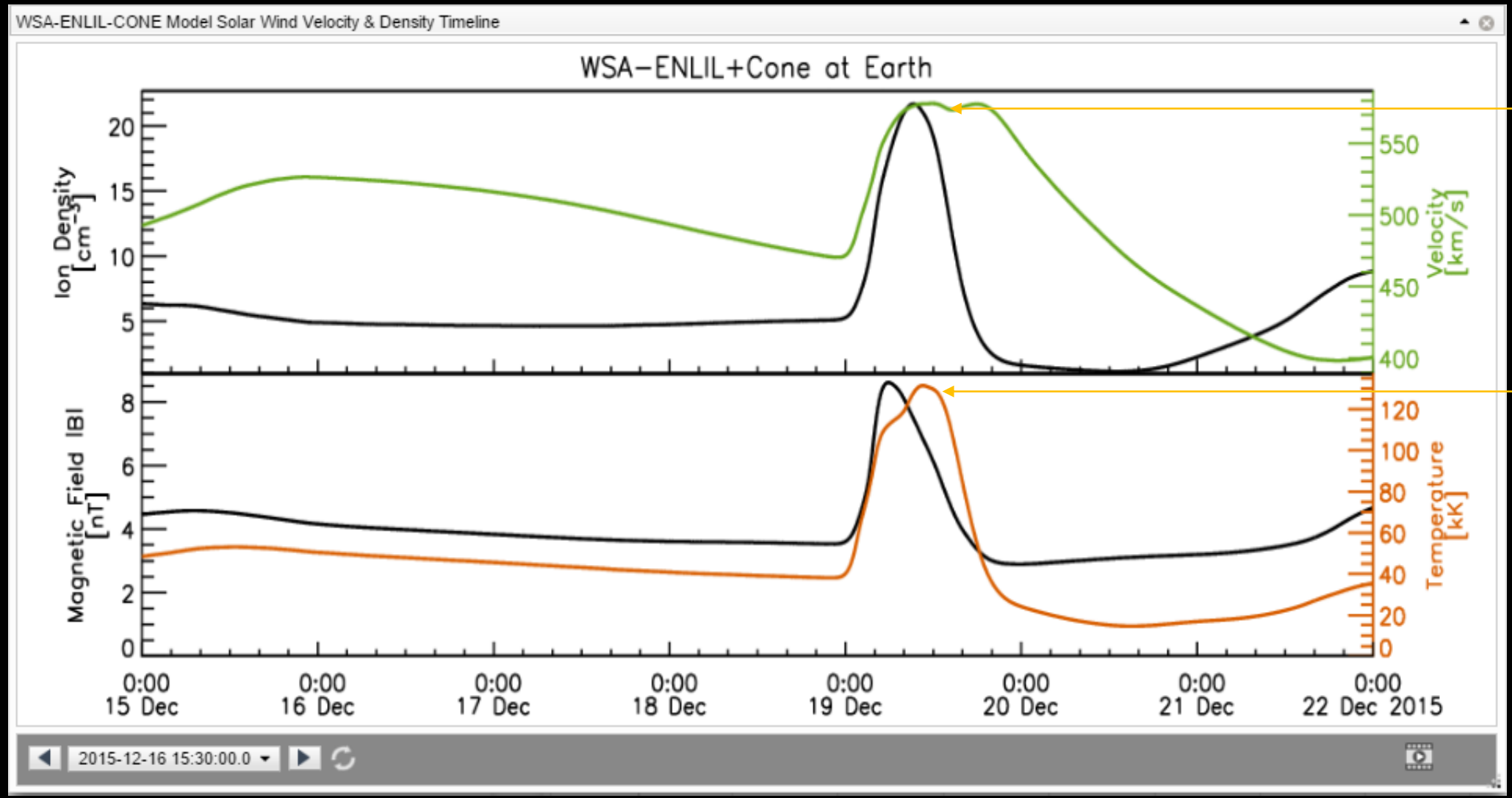

B_x GSE [nT]
B_y [nT]
B_z [nT]
B_Φ
B_θ
IBI [nT]
(12hr)
05/09
(12hr)
05/10
(12hr)
05/11
(12hr)
2015, Month/Day (UT)


Kp Index
New Model Prediction
Kp>4
Kp=4
Kp<4
08 May
09 May
10 May
11 May
12 May
13 May
Universal Time

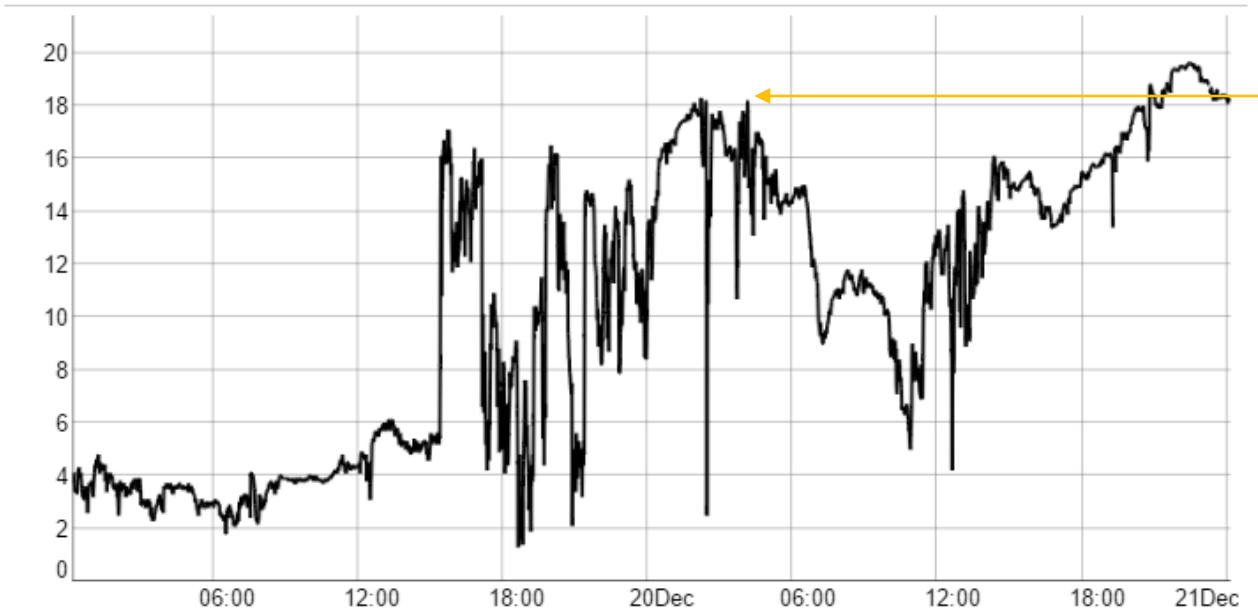
Real-Time Limitations Part I



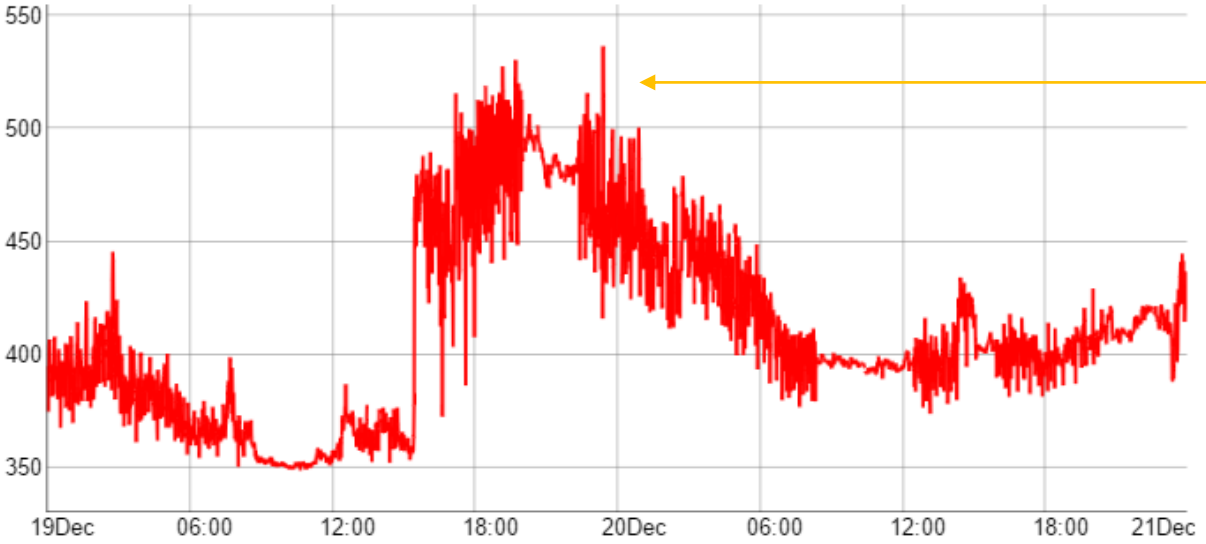
580 km/s

8.5 nT

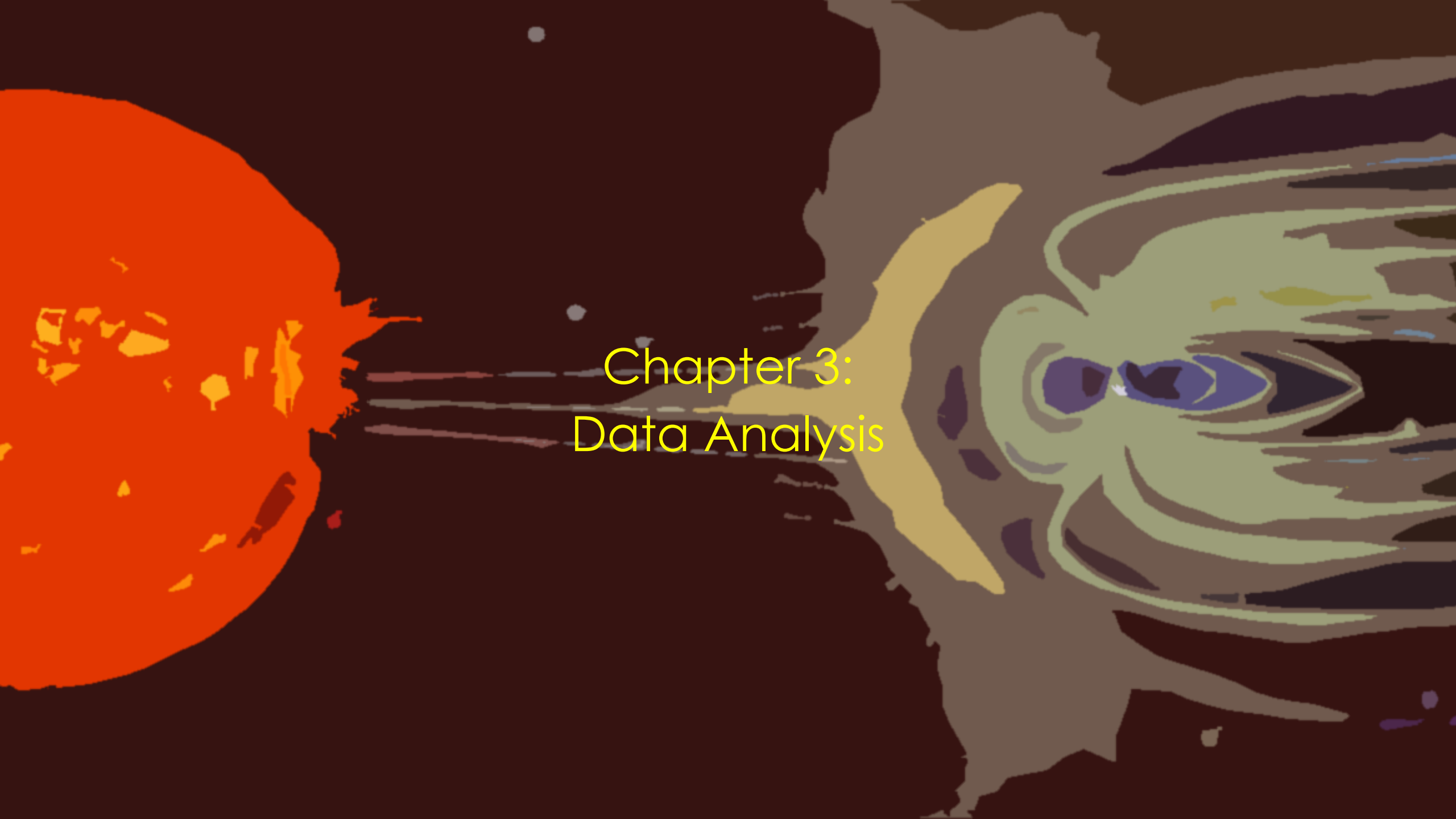
Real-Time Limitations Part II



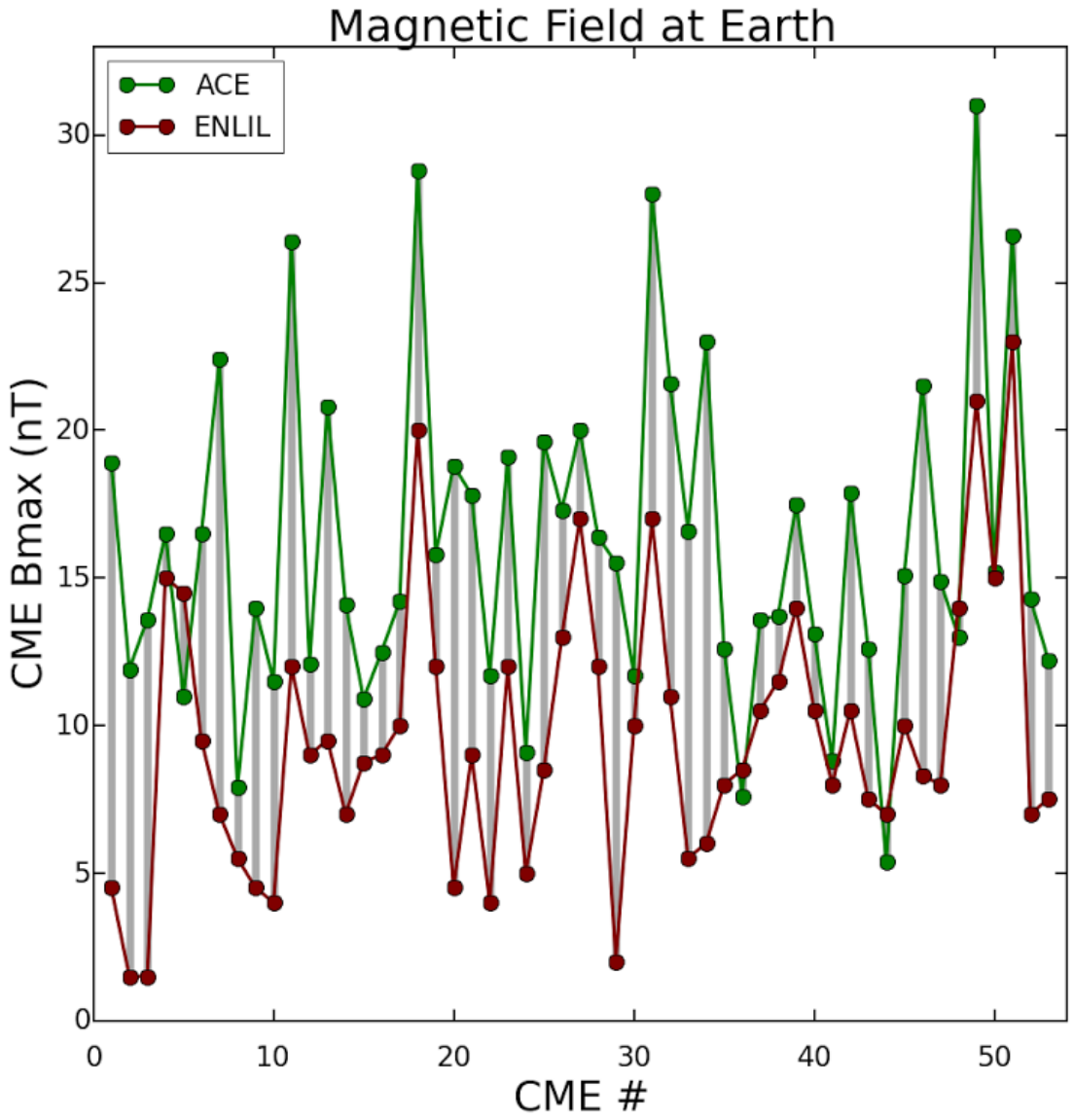
18.1 nT

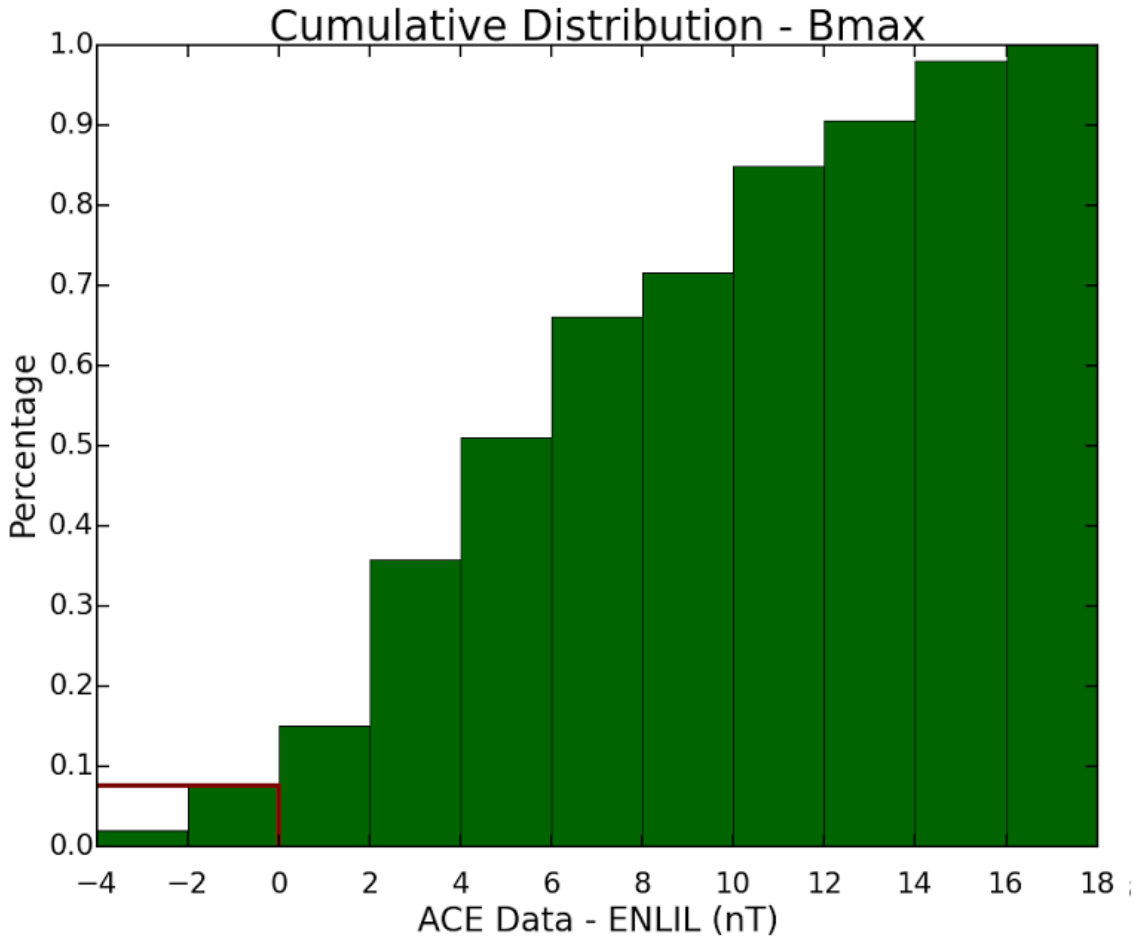


525 km/s

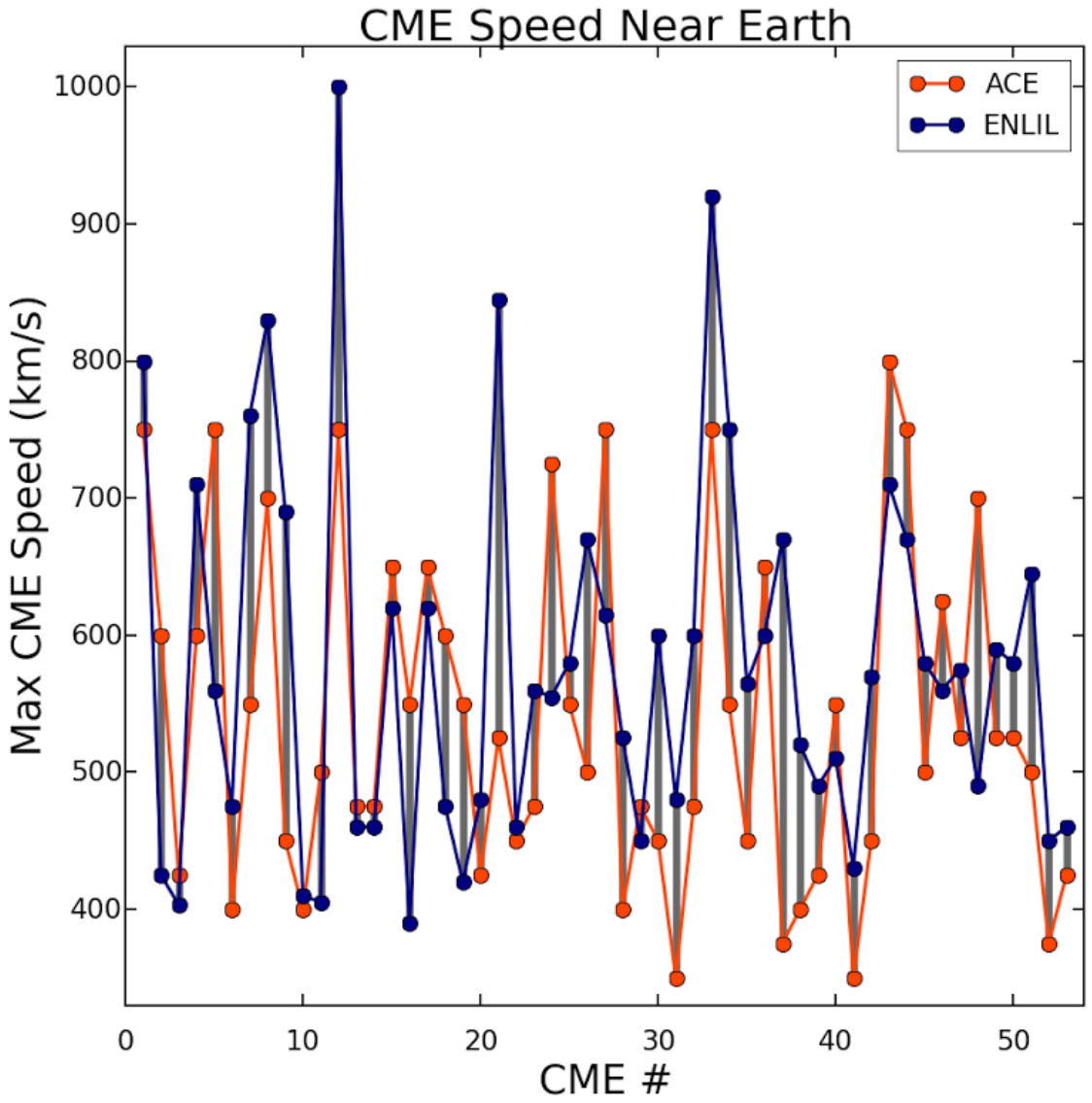

Chapter 3:
Data Analysis

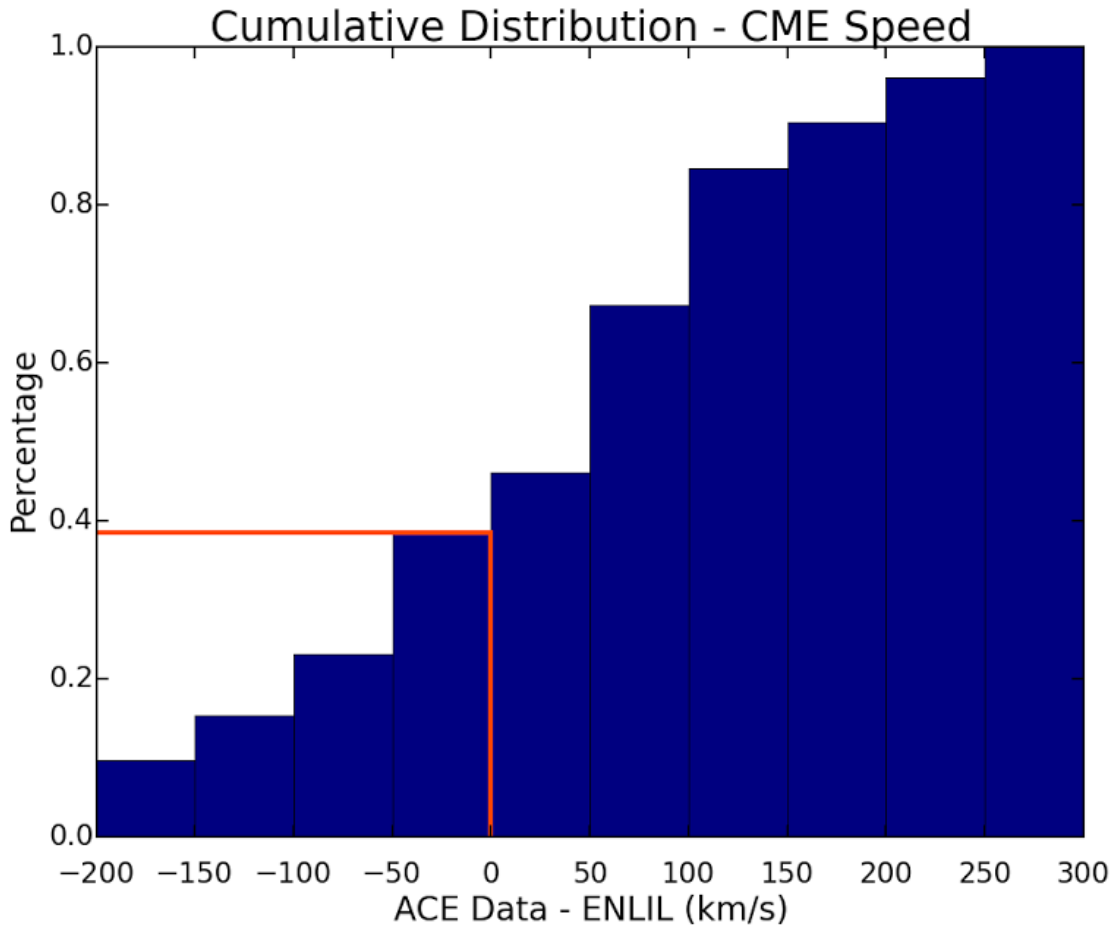
Analyzing ENLIL B-field Predictions



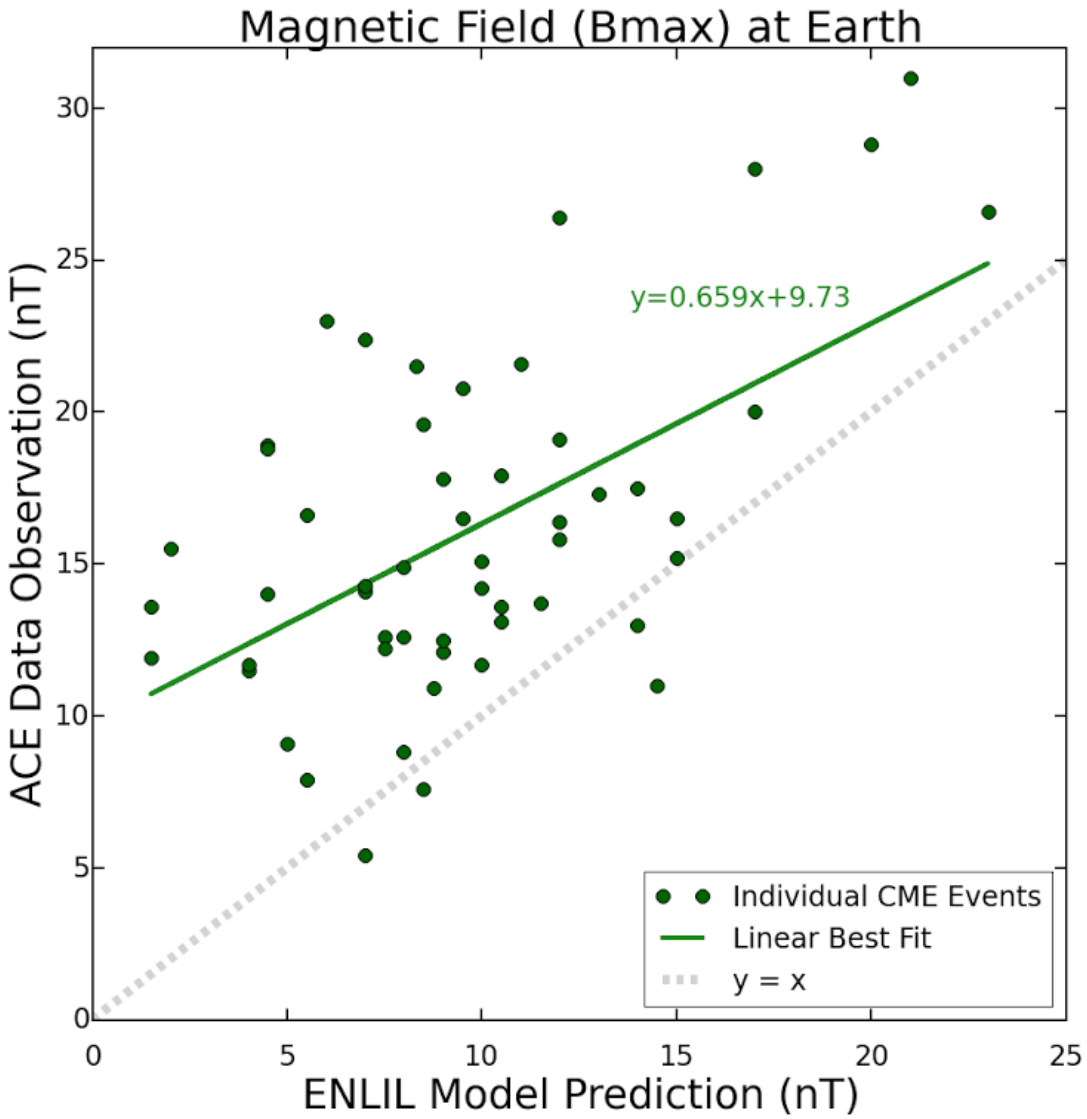


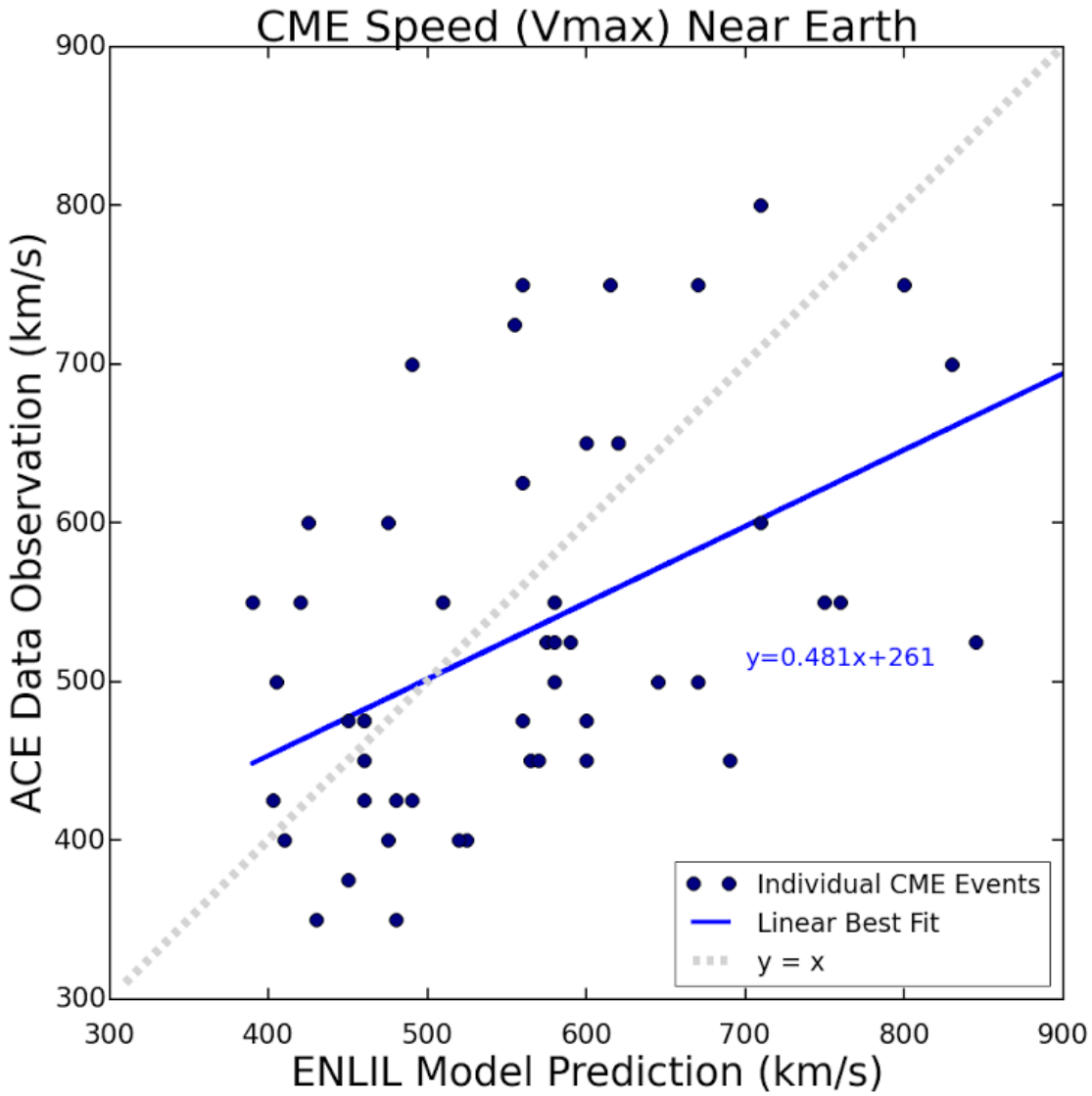
Analyzing ENLIL Velocity Predictions





Finding the "Rules of Thumb"





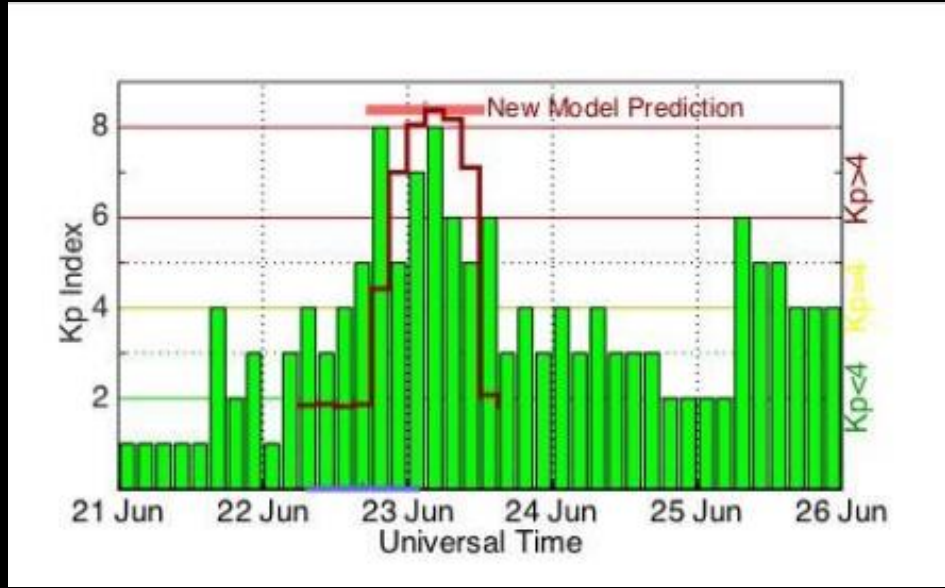
Chapter 4:
Results and Discussion

Skill Score Overview

	Event Observed	
Event Forecast	Yes	No
Yes	A. Hit	B. False Positive
No	C. Miss	D. Correct Null

Skill Score Metric	Minimum	Maximum	Perfect Score
Proportion Correct	0	1	1
Hit Rate	0	1	1
False Alarm Rate	0	1	0
Frequency Bias	0	∞	1
Threat Score	0	1	1
True Skill Statistic (TSS)	-1	1	1

Proportion Correct = (A + D) / n
Hit Rate = A / (A + C)
False Alarm Ratio = B / (A + B)
Frequency Bias = (A + B) / (A + C)
Threat Score = A / (A + B + C)
TSS = (AD - BC) / [(A + C) (B + D)]



Results

Bz4Cast Performance for ENLIL and Modified Inputs

Bz4Cast Inputs	Hits	Misses	False Positives	Correct Nulls
ENLIL	28	37	23	187
Modified	28	37	39	171

Bz4Cast Skill Scores for ENLIL and Modified Inputs

Bz4Cast Inputs	Proportion Correct	Hit Rate	False Alarm Ratio	Frequency Bias	Threat Score	True Skill Statistic
ENLIL	0.78	0.43	0.45	0.78	0.32	0.32
Modified	0.72	0.43	0.58	1.03	0.27	0.25

Discussion

- Only frequency bias showed any improvement
- Four of the metrics were negatively impacted by the input modification
- Noticeable increase in the amount of false positives

- While magnetic field and velocity are relevant, they appear to be more of a second order effect
- Further avenues need to be explored before Bz4Cast can live debut as a real-time forecasting tool

Acknowledgements

This project would not have been possible without the guidance and assistance of Neel Savani, Leila Mays, Yihua Zheng, Barbara Thompson, and Antti Pulkkinen.

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A big thanks as well to all of the CCMC senior forecasters who played a huge role in teaching us about space weather.